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Zonation of intertidal epifauna on jetty piles in Moreton Bay, Queensland.

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ABSTRACT

Zonation of intertidal macrofauna on hard substrates has never been described for Australian sheltered shores as in Moreton Bay. Zonation was studied on jetty piles, which form a suitable habitat for intertidal organisms. The observed zonation patterns and species composition were profoundly different from those of southern Queensland exposed shores. It is postulated that these differences are related to differences in intensity of wave action and considerable variations in salinity and temperature regimes.

INTRODUCTION

Reviews of zonation on rocky shores have been published by Stephenson and Stephenson (1972), Lewis (1964), and Knox (1963). These studies dealt with communities on exposed rocky shores throughout the world, in Britain, and in Australia respectively. In Australia, Endean *et al.* (1956) studied the zonation patterns at many localities along the Queensland coast, following the studies of Dakin *et al.* (1948) along the New South Wales coastline. Subsequently, investigations on NSW exposed shores have been conducted by Underwood (1981). In all of these eastern Australian studies, little mention was made of zonation in sheltered rocky situations. The shores of Moreton Bay (southern Queensland) are sheltered from major wave action and therefore they differ from the exposed shores described by Endean *et al.* (1956) and Underwood (1981). The present paper reports on zonation on some hard substrates in Moreton Bay to determine whether there are major differences in zonation patterns between exposed and sheltered substrates at the same latitude.

Hard substrates colonized by intertidal organisms in Moreton Bay include not only rocky shores and mangrove trees, but also man-made rock walls, breakwaters, jetty piles and navigation beacons. Rocky shores, rock walls and breakwaters are often irregular in surface shape and they have various degrees of slope. Jetty piles and navigation beacons have smoother, more homogeneous surfaces and near vertical slopes. The present paper concentrates on jetty piles because they provide very convenient surfaces for the study of zonation patterns. In Australia, the only other published study of jetty pile biota (Kay and Butler, 1983) was conducted in southern temperate waters. Since they concentrated on subtidal sessile organisms, this present paper is the first to deal with zonation of intertidal organisms on jetty piles.

MATERIALS AND METHODS

Study area

Moreton Bay is a large estuary closed off from the South Pacific Ocean by Moreton and North Stradbroke Islands on the east and a number of smaller islands in the south (Fig. 1). Moreton Bay is 64 km long from north to south and its maximum width is 32 km. Several rivers enter the bay and they can cause considerable fluctuation in water salinity. Surface water salinities, as measured by Stephenson (1968) and Greenwood (1973) usually fluctuate between 30.5‰ and 36.5‰. Lower salinities usually occur during January to March, especially in and near the mouths of rivers, and coincide with periods of high precipitation. Surface water temperatures range between 14.8°C in July and 27.1°C in February (Vohra 1965, Greenwood 1973). The tidal range in Moreton Bay can exceed 2.5 m, but is usually smaller. The tidal influx occurs along a north-south axis, the flood tide takes a southerly direction and the ebb tide a northerly (Newell, 1971).

Both study sites, Wellington Point and Dunwich, are situated in the southern part of the bay. Wellington Point is a small promontory on the mainland and Dunwich is a settlement on the western side of North Stradbroke Island. The jetties at both Wellington Point and Dunwich are situated in an east-west position; the one at Wellington Point pointing eastward from high tide level and one at Dunwich pointing westward. The jetty deck surfaces are supported at constant intervals by pairs of wooden piles that are encased in concrete cylinders to deter the activities of wood borers. At high tide, these cylinders are partly or wholly submerged, depending on the height of the tide and the tidal level of the pile on the shore. At low tide, some piles are completely exposed to air while others are still partly submerged.

Method of sampling

At each jetty the zonation patterns were studied for an eight month period between March and November, 1984. Four pairs of jetty piles ranging from high tidal levels to low tidal levels were investigated. On each jetty pile the outside and inside pile surface were investigated separately.

The following six tidal heights were used to standardize levels on the jetty piles (Department of Harbours and Marine, 1984): Mean High Water of Spring (M.H.W.S.) at a height of 2.0 m above datum, Mean High Water (M.H.W.) at 1.9 m above datum, Mean High Water of Neap (M.H.W.N.) at 1.6 m above datum, Mean Level (M.L.) at 1.0 m above datum, Mean Low Water of Neap (M.L.W.N.) at 0.6 m above datum, and Mean Low Water of Spring (M.L.W.S.) at 0.2 m above datum. The terms "supralittoral fringe", "midlittoral zone" and "infralittoral fringe", as proposed by Stephenson and Stephenson (1972), were used to describe the littoral zones.

At the beginning of the study the M.H.W. level was marked with paint on all piles involved in this study. Determination of the vertical zonation pattern on any one surface of a pile involved observations of the vertical distribution range of each macrobenthic species in relation to the known positions of standard tidal levels.

The relative density of a species at a particular tidal level was estimated by counting the number of individuals that could be observed in an area of approximately 0.06 m^2 (i.e., a quadrat 15 cm high and 40 cm wide). These counts were recorded in the following scale of relative density: present: 1 to 5 specimens found; common: 6 to 15 specimens found; very common: 16 to 25 specimens found; abundant: more than 25 specimens found. The zonation patterns are presented in bar diagrams. Open bars represent the outside faces and shaded bars represent the inside faces. The diagrams are the result of composite observations over the entire eight month period.

RESULTS

Wellington Point Jetty

Fig. 2 shows the abundance and zonation patterns formed by intertidal organisms on a representative pair of jetty piles. On all pile faces, three major zones can be distinguished.

The supralittoral fringe was dominated by *Littoraria articulata* (Philippi) (Reid, 1986). The top limit of distribution was often formed by the top of the concrete cylinder that surrounded the wooden jetty piles. The lower limit of abundance varied between 1.35 m above datum and M.H.W.S. The midlittoral zone was dominated by both the barnacle *Balanus amphitrite* Darwin and the oyster *Saccostrea commercialis* (Iredale & Roughley). *B. amphitrite* was most abundant directly below the *L. articulata* zone, but the zone of its abundance could reach as far down the pile as 0.72 m above datum. The zone of abundance of *S. commercialis* could range from above M.H.W.N. to beneath M.L.W.N. into the infralittoral fringe. Although the transition from one zone to the other was gradual, the limits of each zone were much the same on all the piles.

Besides these three dominant species, several other less abundant species inhabited the pile surfaces. A second species of barnacle, *Elminius modestus* Darwin, occurred infrequently in small numbers. They were only found above M.H.W.N. and they did not exceed the top limit of distribution of *B. amphitrite*. The number of *E. modestus* compared to the number of *B. amphitrite* was almost negligible. The second littorinid *Bembicium auratum* (Quoy & Gaimard) and the limpet *Patelloida mimula* (Quoy & Gaimard) were present on nearly all pile surfaces. They usually inhabited the oyster shells in the midlittoral zone. Small numbers of oyster borers, *Morula marginalba* (Blainville), were observed on oyster shells on some pile surfaces in the midlittoral zone between M.L. and M.H.W.N. The siphon limpet *Siphonaria zelandica* Quoy and Gaimard and the trochid *Austrocochlea constricta* (Dillwyn) were present in relatively small numbers at the lower end of the pile surfaces. *S. zelandica* could only be observed directly attached to the concrete surface and not on the oyster shells. Although *A. constricta* was occasionally found as high as M.H.W.N., a preference for a habitat in the lower shore was supported by a more frequent presence of *A. constricta* on the small rocks surrounding the jetty piles.

A comparison of the various zonation patterns on jetty piles at different tidal levels across the shore showed that the abundance of most species decreased on the shoreward piles. This decrease was more pronounced on pile surfaces facing the sun for a major part of the day than on pile surfaces in a shady position.

Dunwich jetty

The zonation patterns on a pair of jetty piles characteristic for the Dunwich jetty are shown in Fig. 3. All pile surfaces were nearly completely covered with the oyster *S. commercialis*, and there were usually several layers of oysters. *S. commercialis* was the overall dominant species on all the jetty piles. Only in a narrow zone at the top of a pile, above M.H.W., the barnacle *B. amphitrite* could be observed as the most abundant species. On the piles at the highest end of the shore, however, *B. amphitrite* was completely absent or only present in small numbers. In the midlittoral zone the hairy mussel *Trichomya hirsuta* (Lamarck) was abundant. Its distribution ranged from the bottom of the concrete cylinder up to M.H.W.N. The mussels were found in clumps mixed with the oysters. On the first pair of jetty piles at the highest end of the shore, *T. hirsuta* was only observed in small numbers on one of the pile surfaces. The distribution of the limpet *P. mimula* and the littorinid *B. auratum* ranged from M.L.W.N. to M.H.W.S. The distribution range of both species did not seem to exceed that of *S. commercialis*. Their density could range from present to very common or abundant. The oyster borer *M. marginalba* was common on most piles between M.L. and M.H.W. The chiton *Acanthopleura gaimardi* (Blainville) could also be found commonly between M.L.W.N. and M.H.W. The clusterwink *Planaxis sulcatus* (Born) was found in small numbers at mid to high shore levels. The trochid *A. constricta* inhabited the lower parts of the concrete cylinders in small numbers. Very small numbers of the siphon limpet *S. zelandica* were occasionally found, but on most pile surfaces *S. zelandica* was absent.

DISCUSSION

The zonation patterns formed by intertidal organisms on the Wellington Point and Dunwich jetty piles differ profoundly from those described by Endean *et al.* (1956) and Underwood (1981). The littorinids *Nodilittorina pyramidalis* Quoy and Gaimard and *Littorina unifasciata* (Gray) that dominate the exposed shores above M.H.W.S., are replaced by *Littoraria articulata* in the Moreton Bay area. The zone, formed by the barnacles *Chthamalus antennatus* Darwin and *Tesseropora rosea* (Krauss), which is so characteristic of the exposed southern Queensland coast (Endean *et al.*, 1956), is absent on sheltered Moreton Bay shores. These barnacles are replaced by another barnacle, *Balanus amphitrite*, and an oyster, *Saccostrea commercialis* in the same zone. The littorinid *Bembicium nanum*, a common inhabitant of the exposed rocky shores in southern Queensland and in New South Wales, is replaced in Moreton Bay by the closely related species *Bembicium auratum*. Although Endean *et al.* (1956) identified the exposed rocky shore species as *Bembicium melanostoma*, according to Anderson (1958) this should have been *B. nanum*. Some of the less common species that are present on the sheltered shores of Moreton Bay, like *Morula marginalba*, *Austrocochlea constricta* and *Acanthopleura gaimardi* were also recorded by Endean *et al.* (1956) and Stephenson and Stephenson (1972) from exposed shores in southern Queensland. These results show that different marine environments, although in close proximity of each other, can result in a different species composition.

A comparison of the zonation patterns on the Wellington Point and Dunwich jetty piles reveals basic similarities, although some particular differences do exist. The absence of *Littoraria articulata* on the Dunwich jetty piles might be explained by the limited height of these piles, not exceeding M.H.W.S. The distributional range of *L. articulata* on a rocky shore adjacent to the Dunwich jetty does not support this height explanation. The discrepancy in distribution may be explained by the presence of a mangrove forest in close proximity of the Wellington Point jetty. *L. articulata* appears to be a common inhabitant of these mangroves (Morgan and Hailstone, 1986). If *L. articulata* is considered as an inhabitant of mangrove forests, its absence from the Dunwich jetty piles and rocky shore can be explained by a lack of suitable trees in close proximity to the Dunwich jetty and rocky shore.

The presence of *Trichomya hirsuta* on the Dunwich jetty piles can be explained by the position of the jetty piles there at lower tidal levels than the Wellington Point ones. Drier conditions on the pile surfaces at higher tidal levels apparently prevent the establishment of a mussel zone. Inspection of jetty piles at low tidal levels showed the presence of an oyster zone in the infralittoral fringe and at subtidal levels.

The density of *B. amphitrite* and *S. commercialis* seem to depend on the distance of the pile from the shore. At higher tidal levels, the density of these species decreases, possibly because of increased periods of exposure to air. Pile surfaces facing the sun for a major part of the day showed further decreases in species density. The density of *L. articulata* does not seem to be influenced by the position of the pile across the tidal gradient. This species seems to be able to tolerate long periods of exposure to air due to its habitat above M.H.W.N.

Comparing the north and south piles at the same tidal levels, no major differences in distribution and abundance could be observed for most species. At Wellington Point, the south facing piles (Fig. 2B) are in a more shaded position compared to the north facing piles (Fig. 2A), which face the sun for a major part of the day. Especially on the more shoreward piles this results in a marked decrease in species density and distribution on the north facing piles. Some of the less common species, such as *S. zelandica* and *A. constricta*, do occur in somewhat higher numbers and in a wider range on the south facing piles where moister conditions prevail.

The present study concentrates only on Moreton Bay jetty pile fauna. The species composition and distribution on Moreton Bay rocky shores, however, appears to be very similar to that on the jetty piles. The specific zonation patterns and species composition on the Wellington Point and Dunwich jetty piles are probably related to the different physico-chemical conditions that prevail in Moreton Bay. Wave action is less intense than on exposed shores and the fluctuations of salinity and temperature are greater than in the open ocean. Further research on the physiological tolerance of intertidal organisms will be carried out in order to explain their tidal distribution.

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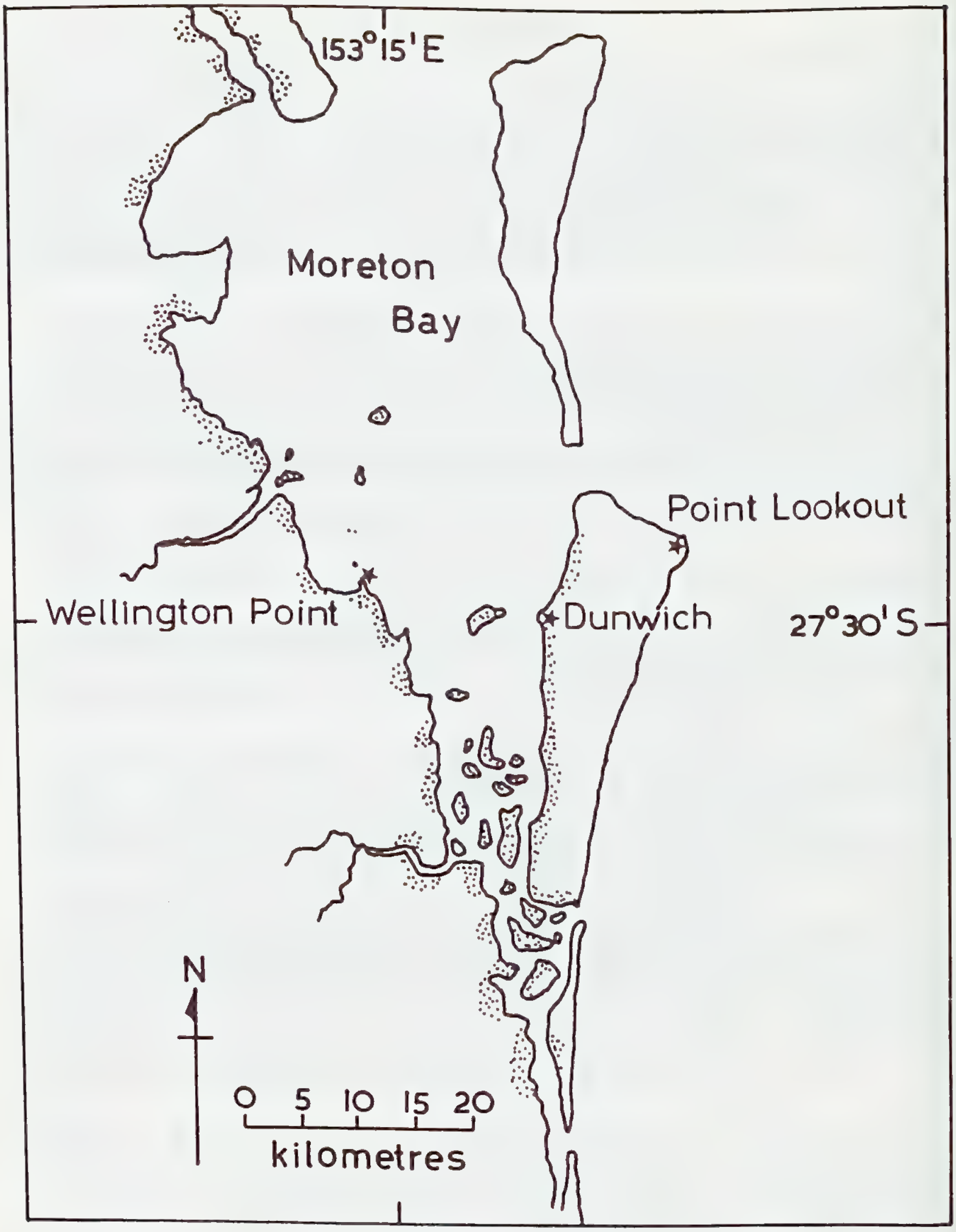

FIGURE 1 Topographic map of Moreton Bay with study sites.

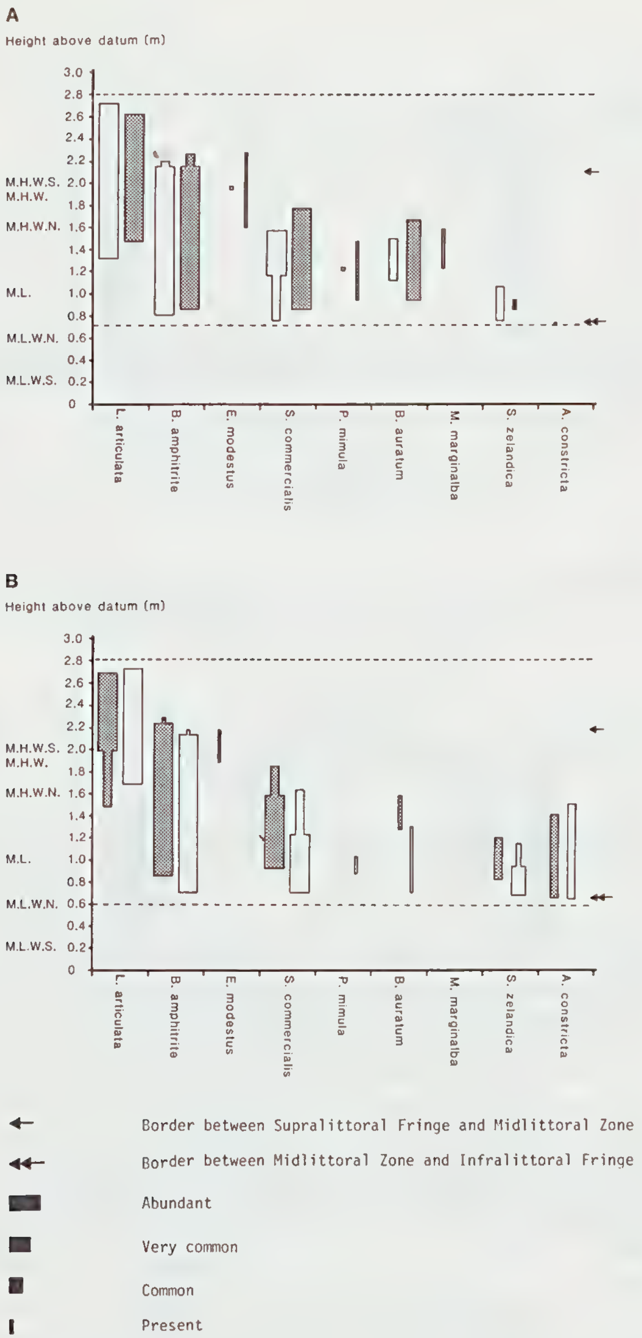

FIGURE 2 Zonation patterns on a representative pair of Wellington Point jetty piles. A. Pile on north side of jetty. B. Pile on south side of jetty. The dashed lines indicated the top and bottom of the concrete cylinders. Open bars represent the outside faces and shaded bars represent the inside faces of the piles. (N.B. Key to species density as shown on photograph)

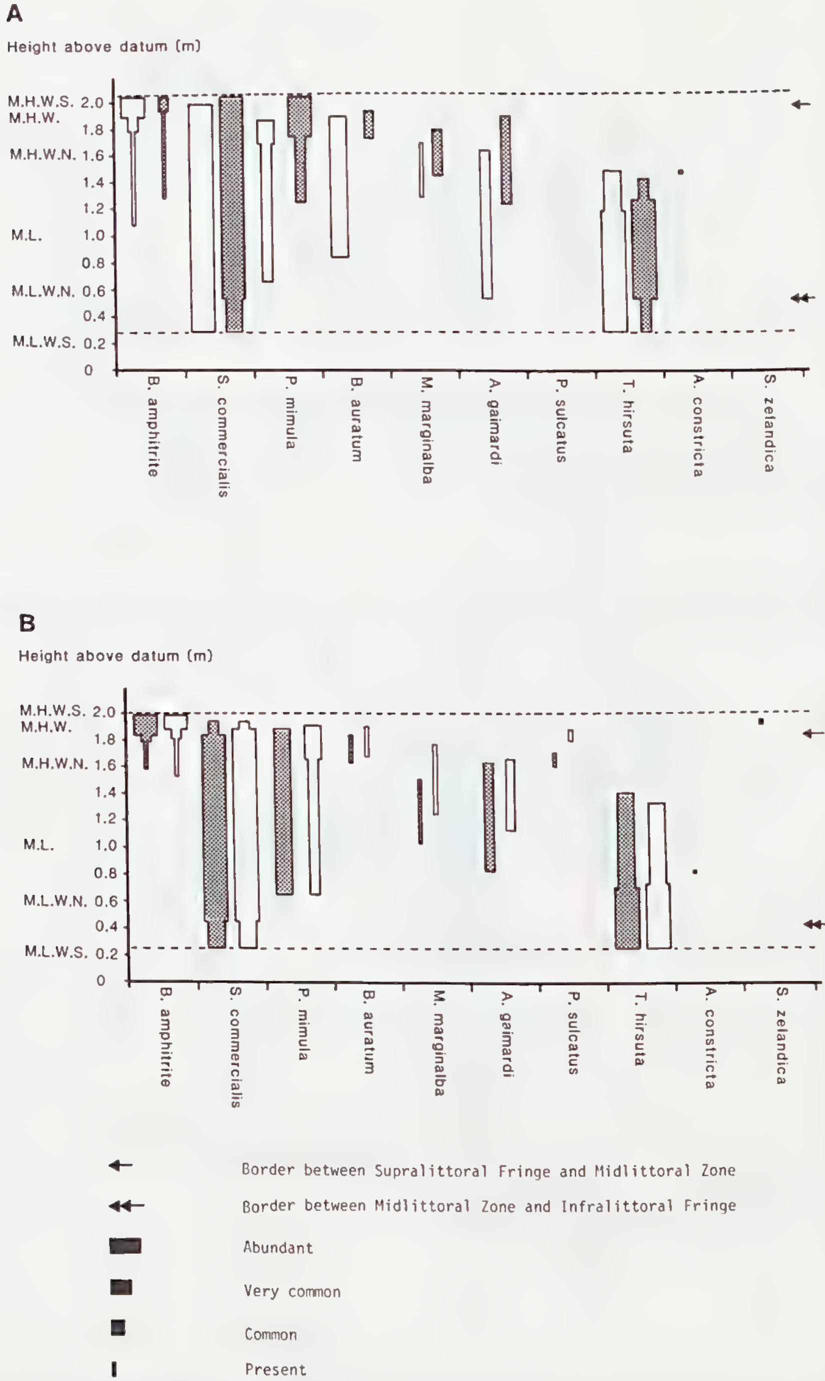

FIGURE 3 Zonation patterns on a representative pair of Dunwich jetty piles. A. Pile on south side of jetty. B. Pile on north side of jetty. Key as in Fig. 2.